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CHINA AEROSPACE STUDIES INSTITUTE

China's Growing Military Space Prowess:
Institutions and Capabilities

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Introduction

Space has become an inalienable part of our daily lives. For everything from agriculture and tele-medicine to national intelligence and surveillance, to everyday navigation and communication, access to space is critical. Modern societies have gotten so accustomed to using outer space that a day without access to outer space is inconceivable. For much of the brief space age, this domain was dominated by the United States and the Soviet Union/Russia. However, over the last couple of decades, relaxation of some of the Cold War technology export control regimes, spread of technology, lower barrier to space access and the growth in the number of actors has democratized access to space.

Even though China's space program began in the late 1950s, it was dependent on the Soviet Union, and the Sino-Soviet split meant that China's space capability was weak until the early 1970s. Mao Zedong's vision for China to develop space power was clear from the very beginning. In fact, in October 1956, the Central Committee of the Communist Party of China set up the Fifth Research Academy of the Ministry of National Defense to focus on space development, which can be called the official starting of the Chinese space program.[1] But the program has had to deal with several upheavals including political and social divisions and instability.[2] All of these delayed the space program to the point where it launched its first satellite only in April 1970. Since then, subsequent leaders of China have paid adequate attention and funding for its space program. The rise of China as a major power has also seen a growth of its civilian and military space program as well. An assessment of China's space prowess through a number of parameters show that they are gaining competency much faster than was anticipated. In particular, China's military space program, developing under the guidance of the PLA, of course under the oversight role of Xi Jinping and the Central Military Commission, has consequences for the Indo-Pacific. Given the nature of major power relations in the Indo-Pacific, these growing Chinese capabilities could very well spur an arms race in outer space, with countries in the region following China's steps.

Since President Xi Jinping came to power in 2012, the PLA has been getting more focused attention and the PLA in turn has paid greater attention to space. This is also in line with the Chinese thinking on the role of space in national development and international security, as noted in some of the official documents. The latest Defence White Paper of 2019 highlighted the need "to improve the capabilities of joint operations command to exercise reliable and efficient command over emergency responses, and to effectively accomplish urgent, tough and dangerous tasks." [3] Space is a critical component in this goal. According to

the 2019 Defence White Paper, "Outer space is a critical domain in international strategic competition."[4]

This paper examines China's military space program. I will start with detailing the institutional re-organisation that Chinese military, the Peoples Liberation Army (PLA) has undertaken to integrate space into its operations. The second section will deal with an analysis of China's growing space capabilities to meet its equally growing security requirements which will be followed by a look at the Chinese development of counterspace capabilities. The chapter will end with a brief analysis of the implications of China's military space prowess for the Indo-Pacific region.

Institutional Re-organisation

In 2015, China began one of the more far-reaching re-organization of its military, with important changes in the command and operational structures of the PLA. One of the key goals of the re-organisation has been to bring about modernisation as well as optimization of the military to create true integration and overall efficiency. Experts argue that the 2015 reforms have both political and operational goals. Bates Gill and Adam Ni, for instance, argue that to the Communist Party of China, the reforms and re-structuring are aimed at "strengthening CCP authority over the PLA; and reorganizing the PLA to become more effective in conducting joint operations."[5]

One of the most pertinent measures pertaining to space in this reorganization is the creation of the PLA Strategic Support Force (PLASSF). Although a critical institutional innovation, there is still very little information about the PLASSF, its role and mandate.[6] Senior Colonel Yang Yujun, Director of the Press Affairs Bureau of the Ministry of National Defense and Spokesperson of the Ministry of National Defense in January 2016 responded during a briefing: "The Strategic Support Force is a new type combat force for safeguarding national security. It is an important growth point of the military's new combat capability. It is mainly formed from the functional integration of various types of support forces with strong strategic, foundational and supportive functions. The establishment of the Strategic Support Force is conducive for optimizing the military's force structure and improving integrated support capabilities. [The PLA] will persist with system integration, military-civilian integration, the construction of new combat forces, and will strive to build a strong and modern strategic support force."[7] One of the key goals for the PLASSF is to also strengthen "peacetime-wartime integration," because the previous strategy had a flaw of having to transition "from a peacetime posture to a wartime posture just prior or immediately after the outbreak of war."[8] This becomes particularly problematic in an informatised and networked system with heavy reliance on cyber and space domains. Developments are likely to take place faster in an informatised environment, which makes the transition that much more challenging.

Rachael Burton and Mark Stokes of the Project 2049 Institute say that the PLASSF is "one of the most significant components" of the 2015 military reforms. From the limited information available, they suggest that "the PLASSF appears intended to integrate the launch, tracking, and control of satellites with the operational units that apply the services that the satellites provide, such as command, control, communications, computers, intelligence, surveillance, and reconnaissance."[9] In essence, the PLASSF has been established

"for dominance in space, cyberspace, and the electromagnetic domain, which are considered critical "strategic commanding heights" for the PLA."[10] Experts also suggest that with the creation of the PLASSF, the effort is to shift away from a discipline-centric approach to a domain-centric one, that would focus on all domain missions together than offensive and defensive separately placed in different organisations, which was the case earlier. As Elsa Kania and John Costello explain, "previously, space, cyber, and electronic warfare units were organized according to the type of mission – the disciplines of reconnaissance, attack, or defense – rather than their war-fighting domain." As the two authors detail, in the case of cyber, for instance, espionage aspects were "handled by the Third Department of the former GSD (3PLA)," whereas the offensive aspects were "handled by the Fourth Department (4PLA), and the former Informatization Department undertook certain elements of defense." The new institutional changes would also allow for combined research and development, planning and force development which were not possible earlier.[11]

Further, the PLASSF Space Systems Department is seen "to have integrated space launch, tracking, and control base commands previously subordinate to the former GAD [General Armaments Department] Headquarters Department." To carry out the functions of contracting satellite launch, tracking, and control services, the GAD Headquarters created a shell designation, titled, China Satellite Launch and Tracking Control (CLTC). The PLASSF Space Systems Department has also the responsibility for the five space launch, tracking and control base commands that were earlier under the GAD.[12] Some of the bases under the PLASSF Space Systems Department are also responsible for Satellite Communications (SATCOM) and ground segment of space-based ISR. A base command with its headquarters in Wuhan has possibly integrated a variety of survey and mapping units. The Xi'an Satellite Tracking and Control Center (formerly GAD Base 26), a corps leader-grade organization, is in charge of space tracking, telemetry and control.[13] The PLASSF is also known to have combined several previous GAD research departments including the Beijing Institute of Tracking and Telecommunications Technology (BITTT). The China Satellite Maritime Tracking and Control Department (formerly GAD Base 23, Jiangyin), another corps leader-grade organization, has the responsibility for sea-based satellite tracking, control and launch vehicle transportation to Hainan.

The significance of the PLASSF comes from the fact that it has become the go-to institution for "strategic-level information support for the PLA in its entirety, enhancing its capability to engage in integrated joint operations and remote operations."[14] It also has "integrated the PLA's capabilities for cyber, electronic, and psychological warfare into a single force within its Network Systems Department," which facilitate synergies among these different assets and operations.[15] It remains unclear if strategic level psychological warfare capabilities remain separated from tactical level psychological warfare capabilities. Therefore, between the Space Systems Department and the Network Systems Department of the PLASSF, PLA's integration efforts to bring the different domains of space, cyber, and electromagnetic domains appear quite effective. Given the PLA's big emphasis on informatised operations, the PLA has also separately established capabilities for "network-electronic operations" within national Joint Staff Department headquarters and the new theatre commands.[16] This eases the conduct of information operations at every level, including at Theatre Commands (TCs).

The fact that the PLASSF is directly under the Central Military Commission (CMC) with direct supervision capacity of two equal, near-autonomous branches – the Space Systems Department and the Networks Systems Department – adds to the possible effectiveness of the institution in bringing about greater synergies and integration.[17] Nevertheless, there are scholars who remain skeptical and feel that these two Departments could part ways, as two separate services, possibly a "Space Force" and a "Cyber Force".[18] The Space Systems Department, with a space force, is responsible for space operations whereas the Networks Systems Department which has a cyber force, has the responsibility for information operations.[19]

The PLASSF Space Engineering University (SEU), a corps leader institution, also falls under the ambit of the PLASSF Space Systems Department.[20] The SEU, from 2019 onwards, is reported to be hosting a "workstation" for the National Defense Science and Technology (S&T) Special Innovation Zone, believed to be a funded research program of the Science & Technology Innovation Bureau of the Central Military Commission's Science and Technology Commission. While the information is scanty on the research responsibilities of this workstation, it is believed to be focused research on spatial information technology, covering "pivotal technologies for modern military decision-making such as remote sensing and Geographic Information System (GIS) technologies."[21] There are other civil research and academic institutions that have been funded by the SEU to undertake classified and non-classified studies, but the autonomy enjoyed by the workstation appears to be unique, seen as "conducive to innovation." SEU is also home to a couple of defence-related national labs including the National Key Laboratory of Laser Propulsion and Applications and the National Laboratory of Electronic Information Equipment Systems. Experts are not entirely clear "how or if any connections exist between the key labs and the relatively new 'innovation workstation'."[22] Marcus Clay of China Aerospace Studies Institute (CASI) has a detailed analysis of the SEU in terms of its education program, outreach efforts, selection process for future space warriors, making it sufficiently clear the importance of the SEU beyond a military educational institution, as a hub of space innovation, a research and development platform for the PLASSF. Clay also suggests that the SEU is likely an important institution testing out concepts like civil-military fusion.[23]

Burton and Stokes also note that the PLASSF is not a separate service wing like the PLA Army (PLAA), PLA Air Force (PLAAF), PLA Navy (PLAN) or PLA Rocket Force (PLARF). Nevertheless, "as a force with the same grade as the four services and five Theater Commands (TC), the PLASSF is treated as a service."[24] PLASSF senior officers are also known to "manage at least three 1st-level administrative departments, two systems departments, and at least 12 corps leader-grade or corps deputy leader-grade base commands."[25] Senior PLASSF leaders are high up in the hierarchy, considered as TC leaders - and TC deputy leader-level officers have responsibility for military space operations, most of China's intelligence, surveillance and reconnaissance (ISR) and strategic electronic countermeasures (ECM). According to Burton and Stokes, the PLASSF's 1st-level departments, which include Staff, Political Work, Logistics, Space Systems and Network Systems, along with the Discipline Inspection Commission, have responsibility for structural integration of space and network operations. The two analysts note that there has been no credible information available on the PLASSF equipment department but broadly conclude that the Force is significant in critical military applications such as command, control, communications, computers, intelligence,

surveillance and reconnaissance (C4ISR). The PLASSF also makes effective use of space reconnaissance assets along with cyber inputs to develop electronic countermeasures. "Cross-domain fusion" is also a major highlight of the work undertaken at the PLASSF.

Given the paucity of information on the functioning of the PLASSF, it is difficult to undertake an assessment of this institution yet. The success and effectiveness of this institutional innovation is unclear given that China has not published much information. But Elsa Kania and John Costello argue that the SSF appears to be similar to the functioning model of the PLA's Second Artillery Corps, what is now the PLA Rocket Force (PLARF), even though there are some important variations. The Second Artillery Corps functioned in a way that saw the consolidation of all "strategic capabilities under direct national control" but it has to be noted that the PLARF administered only land-based "strategic nuclear capabilities." The current effort is similar in combining space and cyber capabilities so as to establish deterrence in these two domains.[26] There are alternate perspectives on this. For instance, there are experts who articulate that the key function of the PLASSF is to help amplify or enhance what the PLA's joint forces are set to do (likely via the space and cyber domain) using the intel gathered via space and cyber means.[27]

Kania and Costello argue that the PLASSF has become an all-encompassing organisation, responsible for "nearly every aspect of PLA space operation, including space launch and support, space telemetry, tracking, and control (TT&C), space information support (i.e. space-based C4ISR), and possibly space attack and defense."[28] With the PLASSF at the helm, they also believe that the PLA is "rapidly expanding its space systems architecture, seeking to develop a space based, information real-time service system capable of positioning, navigation, timing, remote sensing and communication that is leveraged in an integrated manner for civilian and military applications."[29]

Similarly, Dean Cheng, citing Chinese writings, note that China stresses the role of electronic and network warfare in its quest to bring about space dominance for a range of operations including soft-kill methods, using laser dazzlers, cyber-attack against TT&C centres as well as onboard systems and hard kill which includes direct ascent anti-satellite missiles and co-orbital anti-satellite systems. PLASSF commanding all these different capabilities under its command can give it a significantly more advantageous position for effective and integrated operations.[30]

The general understanding is that the PLASSF has been enormously useful a step in bringing about synergy and functional integration. Nevertheless, there are questions raised as to where the PLASSF fits within the overall PLA hierarchy. If such confusion exists in actual structures rather than just because of knowledge gap of external observers, it could potentially lead to problems in the future. There, however, is an agreement that the creation of the Space Systems Department under the PLASSF, has removed some of the "bureaucratic power struggles" that existed among the General Armaments Department, the Second Artillery Force and the PLA Air Force.[31] Experts also suggest that there are some lingering problems in the PLASSF. While the Space Systems Department and the Network Systems Department of the PLASSF are quite significant in bringing about synergy across space, cyber and electromagnetic domains, both during peacetime and wartime, there are reportedly some "incongruences" that persist at lower levels. For instance, there are elements of the

earlier General Staff Department's cyber, space, and electronic warfare capabilities that are still attached to units responsible for other missions. Some of this might be by design, but it nevertheless has the potential for operational dissonance.

Enhancing Chinese Space Capabilities

Operation Desert Storm, the US military operation in Iraq in 1990-91 was a wake-up call to the Chinese military. The US operation demonstrated the power of space assets in carrying out conventional military operations. Since then, the PLA has studied each of the major US military operations to understand the extent of space being used in conventional military operations. Nevertheless, in the 1990s, China looked at space playing a supportive role than a decisive one in military operations.[32] The NATO bombing of Yugoslavia changed the Chinese perception on the use of space assets in military operations. Some Chinese writings even quantified the use of space by NATO in determining the outcome: space assets provided about 70% of battlefield communications, 80% of battlefield surveillance and reconnaissance and 100% of meteorological data, which China believes determined the outcome of the NATO operations.[33] These numbers changed China's perceptions on how space can be put to greater use in military operations.

China over the last decade has rapidly developed its space capabilities. As of August 2020, China has undertaken 22 launches for the year, which included a test flight of the Long March 5B for the Chinese space station missions and its first Mars mission. Of the 22 launches, three were failed launches. In 2018 and 2019, China led globally in terms of the number of launches at 39 and 34 respectively.[34] This is not an accurate assessment of a country's space prowess but it is an indicator of China's enhanced launch capabilities including the launch infrastructure.

China's space program has been focusing on its remote sensing satellites with its Gaofen remote sensing satellite constellation, and navigation with its Beidou positioning, navigation and timing (PNT) satellites. As of May 2018, China has a total of 120 space-based systems, half of which contributes to the PLA's ISR and remote sensing requirements.[35] China also reportedly operates around 30 communications satellites, of which 4 are dedicated to the PLA.[36] China has been also using a series of dual-use and commercial satellites with a range of sensors including electronic intelligence (ELINT), electro-optical (EO) sensors, Synthetic aperture radar (SAR), stereoscopic imagers and hyperspectral imaging. China plans to have "a global, 24-hour, all-weather earth remote sensing system," called the China High-Resolution Earth Observation System (CHEOS) with both Earth Observation and Synthetic Aperture Radar satellites.[37] The Gaofen series of Earth observation satellites that began operating in 2010 have been valuable in providing new imaging capabilities – high-definition optical imaging to China's first SAR-imaging satellite. These satellites form part of the CHEOS.[38] The Gaofen-7 has the capability to produce high-resolution 3D imagery by using multispectral cameras onboard. The August 2020 launch of the Gaofen-9 05 satellite can produce images with a resolution up to the sub-meter level. This was the 343rd satellite mission for the Long March rocket family.[39]

Prior to the launch of CHEOS, the Chinese government had a civilian program called High-Definition Earth Observation Satellite (HDEOS), which was the first of a series of high-resolution optical Earth Observation satellites of the China National Space Administration

(CNSA). CHEOS was approved in 2010 and became an extension of the HDEOS program. The CHEOS program was introduced with the goal of augmenting the overall capabilities of China's Earth observation system and is meant to be operationalized by 2020. CHEOS consists of four elements – space-based system, the near-space and air-borne system, ground system and application system to maintain Earth observation at high temporal, spatial and spectral resolution.[40]

From a military perspective, China's Yaogan series of satellite constellations are considered one of the "most mature and militarily relevant." The first Yaogan satellite, a series of Earth Observation satellites, was launched in 2006.[41] Even though China has claimed that these are being used for land survey, disaster warning, urban planning and scientific experiments, the fact that they are operated by the PLA for imagery intelligence (IMINT) purposes says a lot about the resolution and the overall quality of these satellites. These are mostly dual use satellites with some of them using electric-optical or synthetic aperture radar (SAR) payloads to capture Earth's images from Low Earth Orbit. From an ISR perspective, China's Yaogan satellite constellation offers surveillance over a large swathe of area over the Pacific Ocean.

China has also pursued an active positioning, navigation and navigation program to enhance its tactical advantage in military operations. Navigation satellites are also dual-use satellites with both civilian and military applications. The Chinese have developed a navigation system called the Beidou which has been in operation since 2003. While China initially partnered with the European Union and others to develop a navigation system, it did not make much headway. Thereafter, China went about expanding its own program. On 31 July 2020, Chinese President Xi Jinping announced that its Beidou navigation satellite system was "formally commissioned."[42] Beidou has a total of 56 satellites and is seen as "more advanced, and higher precision and sophisticated coverage."[43] While this is an impressive feat for the PLA, experts believe it will take time to operationalize it to the extent that the PLA can use it effectively. Bleddyn Bowen, for instance, argues that "to truly capitalise on this the PLA needs to distribute a lot of receivers which will take time, and of course its modernizing forces need to get used to conducting high-intensity space-enabled military operations. America and its allies have 30 years of experience in this and have developed a lot of skills and institutional memory on how to use GPS in combat. China can't claim to have that – not yet anyway."[44]

China's pursuit of its space program has many different facets to it – economic and social benefits but "the fundamental driver of the program has always been dictated by military needs."[45] These include also the ground-based and space-based ASAT and other non-kinetic counterspace capabilities which China has been known to be pursuing for more than a decade. China has developed a near full spectrum military space capabilities to win local wars under informationization conditions.[46] Nevertheless, there are significant gaps in China's overall space capability if one were to compare it with the US or even Russian space programs. Even though China has undertaken more launches than any other country in the last two years, in terms of overall sophistication in areas such as space exploration or in reusable space vehicles and space science, Beijing is still catching up. China is of course a determined power, but there are gaps to convert determination to material outcomes. China is trying to address this in a number of ways including by giving space to commercial space

sector, but it is still lagging in comparison to the US. So, while the gap might be shrinking gradually, there still exists a gap with the US, which has in fact forced China to pursue an asymmetric strategy in space as well. This approach is essentially reflected in the development of capabilities that will deny adversaries benefits from using space to maximizing the gains during a military operation.

It must be noted that all of the PLA's space goals including C4ISR and navigation are mostly met by its augmented launch capabilities. The Space Systems Department of the PLASSF has the responsibility for PLA's space launch and support centres and is known to maintain a tight timeline as far as the launch schedules are concerned. This is essentially geared to making China as "space super-power."[47] China had overtaken Russia to have the second highest number of launches in 2019.[48] The Long March-5B will be the most powerful of China's heavy lift rockets, possibly capable of supporting China's future space exploration missions. China has also a few "launch on demand" or "quick response" launch vehicles. These are particularly relevant especially during conflicts in case it wants to replace quickly damaged satellites. China's quick response launch vehicles are reportedly capable of only "launching relatively small payloads into LEO."[49] These launch vehicles include: the KZ-1, LM-6, and LM-11. China could possibly give greater leeway to commercial players to give them the opportunity to develop launch vehicles that can carry payloads to LEO and GEO.

China's Counterspace Capabilities

Greater dependence on space in the security and defence sector has also given way to development of counterspace capabilities. While this is not entirely new there are differences from the Cold War competition between the US and USSR. For one, space use in the military sector was primarily limited to strategic operations like strategic intelligence gathering, nuclear attack early warning and monitoring arms control agreements. Both sides even conducted limited ASAT tests, but they discontinued with them. Space did not have a permeating role in conventional military operations as seen today. Advanced militaries such as that of the US are today so networked, with heavy reliance on space, that it has made countries invest in capabilities to deny adversaries any advantage that may come through use of space. China for instance has recognised that this heavy US reliance on space can be an Achilles heel for the US. From all of the American operations in Persian Gulf, Kosovo and Afghanistan, China has come to the firm conclusion that US "is inordinately dependent on its complex but exposed network of sophisticated command, control, communications and computer-based intelligence, surveillance and reconnaissance systems operating synergistically in and through space."[50]

Acknowledging this, the US Defense Secretary Esper recently said, "We know, for example, that China and Russia are weaponizing space through the development of anti-satellite missiles, directed energy, weapons and more — all designed to hold the United States and allied space systems at risk. They have turned a once peaceful arena into a warfighting domain."[51] In fact, Ashley Tellis of the Carnegie Endowment for International Peace argues that "China's counterspace capabilities is not driven fundamentally by a desire to protest American space policies." Rather it is "part of a considered strategy designed to counter the overall military capability of the United States, grounded in Beijing's military weakness." He argues further that "the weapons China seeks to blunt through its emerging space-denial capability are not based in space: they are the US naval and air forces that operate in China's

immediate or extended vicinity. What are in space are the sensory organs, which find and fix targets for these forces, and the nervous system, which connects combatant elements and permits them to operate cohesively."[52]

A second difference as compared to the Cold War years is the relative ease and willingness among states to develop and even use some of the offensive counterspace weapons. There is a growing number of instances where non-kinetic weapons such as electronic and cyber warfare capabilities have been actually used, though not in combat.[53] Many of the norms that prevailed for more than two decades are being broken by some of the new military space players like China and India. The norm to not conduct as ASAT test was broken in the second half of the 2000s. The use of electronic and cyber warfare means in space is breaking some of the other norms like non-interference in each other's satellite operations. Wrecking these norms can be a slippery slope towards complete weaponisation of space.

China has achieved impressive strides in space since the early 2000s. Along with the growth and sophistication of its space capabilities, there has also been a spurt in the development of China's counterspace capabilities in the last decade. After a gap of more than three decades during which space competition had been negligible between the great powers, space is now at the heart of Asian geopolitics. This is indeed a reflection of the changing balance of power dynamics and the increasingly contested nature of major power relations. China may be engaged in a competitive politics with the US in mind. Nevertheless, the impact on the Indo-Pacific security dynamics is loud and clear. For instance, India that stayed away from getting drawn into the big power space competition between the US and Russia, is today committed to developing its own deterrence capabilities in space to protect its assets in space. India's decision to go down this path was entirely prompted by China's actions. China's first successful ASAT test in January 2007 was a wake-up call for India to the kind of threats and challenges that it should be prepared to deal with.

While ASAT tests bring their own advantages in establishing certain amount of deterrence, they are also seen as risky in many ways. For one, it could result in the creation of large amount of space debris. In one of the worst cases, China's first successful ASAT test in January 2007 created "more than 35,000 shards larger than 1 cm," making it the "worst single debris event ever."[54] Second, testing of kinetic capabilities cannot be hidden from the international community whereas other counterspace capabilities such as electronic and cyber warfare means are a lot easier to handle in many ways. They, for instance, cannot be determined easily if an incident was a result of mechanical failure or it was an intentional attack. What is even more attractive is that the required technology for electronic and cyber warfare in space are easier to procure and available to non-state actors as well. The five different segments of a space system – launch, the control segment, the up-down link segment, the user segment and the space segment – which can all be easily targeted.[55] Therefore, many countries including China are developing an entire range of counterspace capabilities to deny adversaries any advantage they can accrue from use of space. On many occasions, these capabilities are developed and deployed or even used without anyone coming to know of it.[56] Over the last decade, China has invested a great deal in developing a series of counterspace capabilities with the objective of creating disruptions, damaging and denying of space assets that are critical during a crisis or a war.

Several recent studies have highlighted China's growing inventory of counterspace capabilities. According to these studies, China's counterspace capabilities today encompass an entire range that threaten satellites from the ground up to geosynchronous orbit (GEO).[57] These studies and assessments include the US Defense Intelligence Agency's publication, *Challenges to Security in Space*; Project 2049 Institute's *China's Space and Counterspace Capabilities and Activities*; Secure World Foundation's (SWF) *Global Counterspace Capabilities: An Open Source Assessment*; and Center for Strategic and International Studies' *Space Threat Assessment 2020*. According to these reports, China's capabilities include direct ascent anti-satellite (DA-ASAT) weapons, high-powered lasers, co-orbital satellites, directed energy weapons, electronic jamming and spoofing, and cyber means. China has so far conducted several ASAT tests in an effort to enhance the sophistication and maturity of its capabilities. However, China has been masking these tests as anti-missile/ missile defence tests so as not to come under international scrutiny. According to the SWF report, the "Chinese -ASAT capability against LEO targets is likely mature and likely operationally fielded on mobile launchers. Chinese DA-ASAT capability against deep space targets — both Medium Earth Orbit (MEO) and GEO — is likely still in the experimental or development phase."[58] They also hold the view that China possibly has no plans to develop it as an operational capability and deploy in the future – at least, there is nothing that suggests such plans for the time being. China's May 2013 ASAT test reached up to the GEO, which has satellites that are typically used for military communications, early warning satellites and satellites for ISR functions. China has also been experimenting a DN-3[59] ASAT missile that can go up to even higher orbits, without creating debris, and China tested this capability in October 2015, December 2016, August 2017 and February 2018.[60] The recent reports on China's counterspace capabilities see an interesting shift in China's approach to these capabilities. China appears to have "paused, or at least slowed" its pursuit of kinetic counterspace capabilities. The authors of the CSIS 2020 report on counterspace capabilities suggest that this could possibly be due to the fact that these capabilities are now "well developed" or that those activities could invite strong international criticism.[61] But China's non-kinetic counterspace capabilities, including sending inspector satellites for rendezvous proximity operations, appear to be gaining greater focus. Increase in the number of dazzling or blinding (satellites) incidents using lasers, electronic jamming and spoofing and using means to target space systems are a clear demonstration of China's intent at creating strategic vulnerabilities for its adversaries.

Electronic and cyber warfare measures are gaining traction among a number of countries for the reasons mentioned above, plausible deniability being the most attractive reasoning.[62] Electronic warfare employs electromagnetic pulses or directed energy such as laser beams or microwave-bombardments to deny, degrade or disrupt satellite systems. These cause temporary disruption or damage to a satellite or service, while not physically contacting the satellite. GPS satellites are particularly vulnerable to jamming as it can block users from getting accurate positioning, PNT data from those satellites if they have been interfered with. It must be noted that it is the civilian GPS signals that have been primarily targeted because the military signals are fairly robust to withstand these attacks.[63] China has also developed electronic warfare capabilities to jam common satellite communication bands. In fact, commenting on the US drone attack on Iranian General Qasem Soleimani, a Chinese military analyst reportedly commented that "China would be able to shoot down the

drone with its air defenses and, as an added layer of defense, could conduct a "soft kill" by jamming the drone's communications and GPS."[64]

While these counterspace capabilities are being developed and matured, advanced space powers could possibly invest in countermeasures to defeat such counterspace capabilities. All of these developments would suggest space will become a lot more fragile and vulnerable, threatening the long-term sustainable use of outer space.

Some of the earlier instances wherein China has used electronic warfare began way back in 2005. In one of the first instances, "several Chinese scientists claimed to have successfully blinded a satellite in a 2005 test using a '50-100 [kilowatt] capacity mounted laser gun in Xinjiang province.'"[65] In a subsequent incident, in 2006, China took steps to blind US spy satellites that flew over Chinese territory with high-powered lasers but the effectiveness of that operation is not known.[66] American officials claimed that China possesses this capability and has "exercised it."[67]

China has also engaged in a series of cyber warfare in space. Like electronic warfare, these technologies are cheaper and the entry barrier is quite low, making even individual hackers a serious threat. This also provides opportunity for deniability and difficulties in attribution make it a more usable weapon. In 2017, a senior US military officials stated that cyber-attacks are the "No. 1 counter-space threat."[68] The Director of US National Intelligence, James R Clapper, has also made similar assertions.[69] There are many verified incidents of such attacks.

For example, a 2019 NASA Inspector General report refers to many Chinese cyber intrusions into NASA, including a 2009 Chinese cyberattack on the Joint Propulsion Laboratory (JPL), with 22 gigabytes of data transferred to a Chinese IP address.[70] Another report by the US-China Economic and Security Review Commission in 2011 stated that two US satellites were compromised in 2007 and 2008 through a ground station in Norway. The attack, carried out via cyber means, was traced back to China. The US government did not blame China but it stated that the attack could be linked to Chinese hackers, and the tactics were consistent with policy statements contained in PLA documents. The attack was considered quite serious because the hackers managed to complete all the process for gaining control of the satellite.[71] In 2011, there reportedly was another incident of data transfer to Chinese IP addresses where "intruders gained full access to 18 servers supporting key JPL missions, including the DSN [Deep Space Network] and Advanced Spaceborne Thermal Emission and Reflection Radiometer mission and sensitive user accounts."[72] Similarly, there was an incident in 2014 when a satellite belonging to the US National Oceanic and Atmospheric Administration was hacked. The attack was once again traced to China.[73] In 2018, the US National Aeronautics and Space Administration came under a cyber-attack wherein personal data of current and former employees were compromised.[74]

As for institutional responsibility for ASAT and other kinetic weapon systems, there is no clarity on who is responsible for research and development as well as testing and deployment of Chinese ASAT capabilities. Experts note that these could fall under the space attack and defense categories, which could bring them under the PLASSF mandate. The other

possibility is that these fall under the responsibility of the PLA Rocket Force or the PLA Air Force.[75]

Similarly, Space Situational Awareness (SSA) have become critical for any capable space player, and China has also been investing resources to develop effective SSA capabilities. But China may have been fortunate in being able to collect open source intelligence about American space activities, facilitated by the huge amount of information on the US space systems and capabilities available through a number of open sources such as the scholars and journalists, astronomy societies, and multilateral regulatory agencies. There are reportedly a number of technical solutions – specialized optical telescopes and theodolites, laser satellite-tracking devices such as rangefinders, large phased-array radars, and other radars associated with surface-to-air missiles, ground and space-based signals intelligence systems – being developed in order to track orbital bodies travelling over China and have the ability to search, acquire, track and classify objects that are of interest to China.[76] With China's growing space capabilities, its SSA capabilities too have been expanding. In fact, China's SSA capabilities are managed by the PLASSF.[77] China's surveillance systems include "a tracking center in Xian, fixed land-based sites, at least one mobile system and as many as seven Yuanwang tracking ships capable of operating throughout the Pacific, Atlantic, Indian oceans."[78] The PLASSF also has satellite ground stations in foreign countries. China has set up ground stations in several countries including Chile, Sweden, Australia, Namibia, Pakistan, and Kenya.[79] While SSA is generally passive and immensely useful while conducting one's own space operations, they are also capable of snooping on adversaries, depending on the kind of radars and sensors they deploy.

Conclusion

China's space program has gained in overall proficiency and capability in an effort to catch up with the US. This has been facilitated by decades-long economic growth and the larger kitty available to invest in both human and material capacity. The changing balance of power equations have had a determining driver in Beijing's pursuit of its space capabilities, especially the military facet of its space program. While China may pursue its space program with the US as the primary competitor, it also has implications for the Indo-Pacific region. In fact, China's active pursuit of its military space program including efforts at weaponisation of space has spurred new competition and rivalry in space, which was somewhat absent for a couple of decades. Along with the capability development, China's institutional innovation measures such as the creation of its own version of Space Force, the PLASSF, has brought about greater synergy in terms of institutional functions but also greater integration of its space, cyber and electronic warfare assets. The unified nature of the PLASSF in combining these functions could bring about greater efficiency on the battlefield. These are significant from an Indo-Pacific strategic perspective but space being one of the global commons, China's actions spanning across these sectors have implications for security in space and space sustainability. However, there is no way to assess the effectiveness of these measures as yet. But China is pursuing space program with a dogged determination, because it also perceives it as granting China a great power status globally.

India would have preferred that there would have been rules of the road to bring about some restraint in China's military space activities but increasingly India appears resigned to the fact that there will be state competition in space that would lead to greater

weaponization. Therefore, India has felt the need to protect its own interests and has been compelled to pursue its own capabilities as a way of deterrence against China's growing military space capabilities. India's own ASAT demonstration in March 2019 was a direct result of the Chinese growing capabilities and an effort at sending a message to China. While India is still interested in maintaining space as a peaceful domain, multilateral efforts at developing norms or legal measures have gone nowhere. India will still pursue multiple tracks at pursuing space governance measures, but ignoring the growing threats in space will be detrimental to India's security.

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